SHM Topic Quiz

      

 * * g = 9.81ms-2

 ** 

***Question ONE: Earth-tunnel***

The year is 2050. Zhu & Co are planning a new way of travelling from Auckland to London (on the opposite side of the earth). Few people think it is feasible, but Susan is planning a tunnel that passes through the earth’s centre. Passengers will be put in a capsule and dropped down the tunnel. She works out that the force on the capsule due to gravity **decreases** linearly as the tunnel approaches the centre of the earth.

distance

Force

The graph on the right shows how the gravity force on the capsule varies with distance to the earth’s centre

(a) Explain why the **motion** of an object dropped into the tunnel would be **SHM**

The earth’s radius is 6.3 x 106 m.

The acceleration due to gravity at the surface is 9.8 ms-2 and zero at the centre.

The acceleration of an object moving in SHM is given by: a = -ω2 x

(b) Show that the angular frequency of the capsule is 0.00125 rad s-1.

(c) Calculate the capsule’s speed at the trip’s mid point.

(d) State the size of the acceleration when the capsule is halfway to the centre.

(e) Calculate the time it takes to travel from Auckland to London, assuming there is no air resistance or friction.

(f) The graph below shows the capsule’s distance from the centre as a function of time. COPY this graph and on the same axis, draw and label graphs of **velocity versus time** and **acceleration versus time**.

Distance

From Centre

Time

2000 km

1. The reference circle to the right shows the journey.

Calculate the time taken to do the first 2000 km.

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Calculate the time taken to do the first 2000 km.

Year 13 SHM Unit Test 2008 - ANSWERS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ANSWER | Achieved | Merit | Excellence |
| ONE (a) | * The acceleration is proportional to distance from centre. * The acceleration is in the opposite direction to the displacement. | Explains one idea.  A1 | Explains both ideas.  M1 |  |
| (b) | **SHOW**:    0.001247… **≈ 0.00125 rad s-1** | Correct acceleration used (**9.8**)  A2 | Correct working **shown**  M2 |  |
| (c) | = 7857.48…**≈ 7900 ms-1 (2SF)** | Correct formula for vmax  A2 | Correct working and answer  M2 |  |
| (d) | = **4.9 ms-2** | Correct answer  A1 |  |  |
| (e) | gives: = 5037.75… seconds  Time from Auck to London = ½ T  = 2518.87… **≈ 2500 s (2SF)** |  | Correct idea of **½ T**  M2 | Correct working and calculation  E2 |
| (f) | Velocity  Acceleration |  | **One** curve correct  M1  Accept negative velocity graph – since object starts moving DOWNWARDS | **Both** curves correct  E1 |
| (g) | 2000 km  ωt  y  A  Reference Circle  θ  y = 6,300,000 - 2,000,000 = 4,300,000m  gives:  θ = 46.957…°  gives:  = 657.11… **≈ 660s (2SF)**  **OR: (using radian setting on calculator)**  y = A cos ωt  4.3 x 106 = 6.3 x 106 cos(0.001247…t)  cos(0.001247…t) = 0.6825…  0.001247..t = 0.819… radians  t = 657.2…**≈ 660s** | Correctly identifies y as 4,300,000m  A2 | Correct diagram  OR  correct calculation of angle in degrees or radians  M2 | Correct answer  E2 |